# Preservation of Digitally Recorded Sound

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*The views and opinions expressed herein are those of the author and do not necessarily reflect those of the U.S. Government or the Library of Congress.*

## INTRODUCTION

In 1878, Thomas A. Edison speculated for the press on the possible uses of his phonograph, the first device for recording and playing back sound. Among the ten applications he predicted were recording music, aiding business dictation, preserving reminiscences (oral histories), creating talking books for the blind, and recording educational lectures. In 2001, all of Edison's predictions have come to be, and uses not imagined in the nineteenth century are common. Now, every day, thousands of hours of sound are produced and disseminated by the radio, compact discs and cassettes, and the World Wide Web. People throughout the world, in all economic strata, depend on recorded sound for entertainment, information, and intellectual stimulation.

The twentieth and twenty-first centuries are documented and recorded by sound and image as well as by words. We perceive much of the world through packaged and broadcast images and sounds. Our experiences today, and those of the last one hundred years, are documented in these media for the study and enjoyment of generations to come. Sound recordings carry the voices and music that have shaped a century, voices of personal ancestors as well as politicians and prominent national leaders. Recorded music in archives includes unique aural documentation of indigenous peoples; the varied jazz, sacred music, and popular and folk songs that form the roots of contemporary rock; and the multi-million sellers themselves. Broadcast radio news collections document historical events and how they were presented to the public and understood by millions.

The great challenge to the librarians and archivists who are entrusted with preserving our culture for posterity is which, and how much, of the thousands of hours of sound recorded daily to retain. Similar challenges have always faced caretakers of culture. However, with so much sound now available, through many media and in many formats, the difficulties have escalated. That these sounds are now predominantly "digital" makes the challenges more formidable and the opportunities more extraordinary.

Sound has been recorded digitally since the 1970s when Pulse Code Modulation (PCM) recording became an accepted method of recording by audio engineers and producers. Today, digital recording techniques and processes contribute to nearly every recording made or distributed. Digital sound, however, has evolved in meaning as it has proliferated in use. In the consumer marketplace, compact audio discs, World Wide Web audio streaming, MP3 sound files distributed through the Web, and DVD audio discs all fall under the rubric of "digital audio," yet they have been created to varying standards and in a wide variety of formats. Today, a digital recording is as likely to be a computer file, with no tangible attributes, as it is to be a compact disc or digital audio tape (DAT).

For example, the sound collection of a large library might include 78-rpm jazz recordings on shellac and vinyl long-playing discs and re-recorded on R-DAT cassettes, and the published recordings of a contemporary rock band recorded on compact audio discs, with unpublished recordings of the same band on MP3 files. The library might hold a group of vintage radio dramas on instantaneous analog discs that have been reformatted for preservation on open-reel analog tapes. An oral history collection or other field research recording might be found on the Sony digital MiniDisc format. The audio reserves service room of a university library might be holding a collection of MP3 files recorded from contemporary radio talk show broadcasts streamed on the Web.

With the development of the World Wide Web have come new digital sound formats and delivery systems that offer archivists, as well as home consumers, a wider variety of recorded sound, instantaneously, than in any time in history. MP3 files, sound files created by an algorithm that highly compresses (reduces) the amount of data required to convey the audio information, proliferate on the Web, illegally as well as legally. Commonly, MP3 files consist of "home-recorded" tracks by aspiring popular music groups, illegally distributed commercially-owned recordings of contemporary and older popular music groups, and spoken-word and music recordings made available for free or offered for sale by legal owners or licensees. In addition, thousands of individuals and corporations offer music, spoken-word recordings, and radio programming over the Web as "streams," continuous sound delivered from Web sites to which users have no choice of content beyond which site to monitor. Whether these sound recordings are going to be maintained for posterity or only for the next ten years, if they are to persist it will be as digital recordings of some type.


**TYPES AND RIGHTS**

Major sound archives hold many conventional forms of commercially produced analog sound recordings, such as 78-rpm "course groove" discs, $33^{1/3}$-rpm long-playing "microgroove" recordings (LPs), and cassette tapes. Whether of music or spoken-word, the recordings are usually the aggregate creation of several parties. These creators have varied rights to the use of the recordings. Copyright in the sound recording itself is usually held by the corporation that issued the recording, the record label. Most recordings are representations or performances of an "underlying work," a musical composition or literary text, which is protected by its own copyright. A royalty based on sales or use is paid to the holder of the copyright in the underlying work. Yet, while these may be the only copyrights, per se, in the recording itself, other rights may be inherent in the work. Printed materials included in the packaging, both textual and graphic, may be protected by copyright, including again, underlying rights as well as protection for new matter. Vaguer, and more complex, are the possible rights in recordings held by trade union members and other artists who contributed to the recorded work. American Federation of Musician or other union recording contracts with record companies may call for additional fees to the union for uses beyond single-unit retail sale.

Many archives' most significant holdings are not commercially produced recordings but are unpublished recordings of various types. Such works include radio broadcast recordings, television sound tracks, "live" musical or dramatic performances, ethnographic field recordings, and interviews. It is in these recordings in which rights issues are most complex and in need of study, and perhaps adaptation, as they relate to preservation. When a corporate body, for profit or non-profit, such as a broadcast network/station/producer, or music producer creates these unpublished recordings, that body often owns the rights to the recording. And, as with commercially distributed published recordings, unpublished recordings are usually interpretations of music or

literary underlying works which are commonly protected by copyright. Because the recordings were intended to remain as unpublished works when they were originally made, the producers were very unlikely to have entered into any contractual agreements with their co-creators, such as members of creative trade unions (musicians, actors, writers and announcers), authors of underlying works, or interviewees. In some recordings, such as unauthorized tapings of live performances ("bootlegs"), none of the contributors to the work, including the producers, were aware that a recording was being made.

It is important to note that in the United States, federal copyright protection was not available for sound recordings until 1972. However, state and common laws protect these recordings until the year 2067, no matter when they were first created. This means that, in effect, the law grants greater protection to sound recordings than to print materials. Determining exactly which parties hold the rights to a pre-1972 recording can present significant challenges because no centralized registration exists as it does for post-1972 federal copyright protection.


## AUDIO ACQUISITIONS

The radical transformations that have made digital formats the predominant form of sound recording have made available to the public more types of sound recordings, and greater numbers of hours of audio, than ever before. As a result, research library administrators responsible for collection development policies must reevaluate their long-range goals regularly as well as their day-to-day acquisitions. No longer are acquisitions limited to physical items offered by retailers and in catalogs, or purchased on their behalf by standing order dealers, contracted purchasing representatives. Rather, librarians and archivists face a plethora of technologies, platforms and genres.

### Compact Discs: The First Digital Audio Revolution

In the consumer arena the digital audio revolution began in the early 1980s when the compact audio disc format was introduced. Public adoption of the compact disc format burgeoned beyond anyone's expectations. The public, and libraries, were attracted by the lack of surface noise and hiss heard on discs and tapes and the silver discs' touted invulnerability to normal wear. The sound on compact discs was criticized by audiophiles, collectors with high-end playback equipment, and other consumers, but most consumers never heard their arguments or the aural evidence. In fact, the 44MHz 16 bit sampling rate, or amount of compression, selected by the creators of the compact discs was a compromise which sacrificed sound quality at the expense of time capacity of the discs. As would be in the case in the late 1990s with even more radically compressed MP3 audio files, convenience and cost proved to be more important to consumers than high fidelity. But years after the introduction of the compact disc, manufacturers' claims of its indestructibility have been debunked. Archives that plan to make their holdings permanent will have to reformat CDs just as they will audio tapes and other fragile media.

Initially, the content of compact discs replicated that of the LP discs they would supercede. However, record companies gained significant profits from the re-release of older catalog issues, in addition to new releases. This new market for "old" holdings paralleled the growth in numbers of re-releases of motion pictures on video tape at the same time. Companies rediscovered the value of their archives of older intellectual property. In many cases, they discovered that they had prematurely destroyed their own masters under the mistaken assumption that there was no "aftermarket" for them. The

convenience and lack of background noise on CDs prompted the public and libraries to recreate their holdings of LP discs and replace them with CD reissues.

Serious sound archives dedicated to documenting the history of music and sound recording continue to acquire LP and 78-rpm discs for their unique repertoire and their audio quality. Stored properly, the discs will last many years, but they deteriorate from repeated playback and high-quality disc playback equipment is expensive. It is also becoming more difficult to acquire the hardware to playback the recordings adequately.

With compact discs came myriad comprehensive recording reissues. The complete recording careers of hundreds of notable classical, jazz, blues, and rock artists have been thoroughly documented on thousands of CD reissues. These discs and sets have enabled libraries to build research-level, encyclopedic collections of important musicians and recording artists. These are recordings the libraries might not have obtained otherwise, either because of inaccessibility or the expense of obtaining and maintaining the original records.

Two important points related to reissues must be emphasized. Most comprehensive jazz, blues, and classical reissues are produced outside of the United States in countries where older recordings are no longer protected by copyright. In most European countries, the copyright on a sound recording is 50 years from the original date of recording. In the United States, it is 95 years from the date of recording for post-1972 recordings and, possibly, until the year 2067 for pre-1972 recordings. (It is usually only the recording that has entered the public domain overseas. The underlying works, the musical compositions, are protected by longer copyright terms and the royalties due on them are often paid.) Most jazz and blues reissues sold in the United States are, technically, illegal imports. However, as the 50-year span enters the rock and roll era it will not be unexpected to see stricter enforcement of the U.S. law or pressure on European countries to change their laws to conform with those of the United States.

The profusion of exhaustive reissues available to libraries presents challenging selection and preservation issues. For while liberal foreign copyright laws enable publication of thousands of previously out-of-print recordings, the quality of these reissues varies greatly. While the producers of comprehensive reissues make thorough searches to locate one copy of every recording an artist has made, the copy used is often generations away from the master recording and in only mediocre condition. To compensate for the condition of the source recordings, many producers of reissues misrepresent the original recordings with signal processing: overuse of noise reduction, sound equalization, and limiting tools in order to reduce the surface noise found on the source. The result is a quiet recording that distorts the richness of sound on the master recording. When the time comes to preserve these recordings it will be very difficult and time-consuming to select the best source material from the abundance of available issues.

**New Means of Digital Audio Distribution**

Compact discs brought significant changes to archives but they pale in comparison to the changes that digitally created and distributed sound files will bring. Today, many archives are rethinking their acquisitions policies, preservation techniques, and delivery systems. The sheer number of new audio materials made available through the World Wide Web is astounding. The greatest attention has been paid to MP3 files legally and illegally traded by millions of people through peer-to-peer networking programs such as Napster. Music publishers and record companies halted the use of Napster as a source of free copyrighted music, but the programs' great popularity has resulted in the development of authorized paid subscription services which intellectual property

holders hope will take its place. This phenomenon will have ramifications for library acquisitions. There is promise for more thorough audio acquisitions programs facilitated by streaming sites, as well as subscription services offered by Web companies.

In general, post-1960 radio broadcasts are represented more sparsely in archives than is any other contemporary mass medium. Popular public radio broadcast series have long been available for sale on audio cassettes, but few other radio broadcasts are available to libraries or the public. Before radio broadcast streaming over the World Wide Web, one could acquire commercial radio broadcasts by tape recording them or by subscribing to a service that sells recorded samples of a station's "sound," its mix of disc jockey patter, public service announcements, and station ID, and its advertisements. Programming archives are held by public radio production and distribution companies, such as National Public Radio and Minnesota Public Radio, but few popular commercial broadcast radio series are collected systematically or preserved in any manner. Twenty years ago, a popular radio talk show that featured nationally renowned guests offered its archive to the Library of Congress. The Library turned down the collection and the tape collection was subsequently destroyed.

**Radio on the World Wide Web**

A large number of radio broadcasts, contemporary and vintage, are streamed on the Web. By one estimate, more than 2,500 radio stations stream all of their programming. This figure was from before April 2001, when a strike was called by AFTRA, the actors union which is demanding supplemental payments to its members for streaming of radio advertisements in which they appear. In addition to individual stations, more than 30 radio networks stream over the Web.

Computer software, such as that sold by High Criteria, Inc., enables streamed audio to be recorded and converted to WAV or MP3 files. Streaming is not intended to be recorded, or fixed, by the user. The laws and licenses that govern streaming were designed with the assumption that its use is ephemeral. It is unknown whether recording streamed audio for archival purposes is legal. However, under the provisions of the American Radio and Television Archives law, which was enacted in 1976 to support an archive of American broadcasting at the Library of Congress, the Library of Congress may be allowed to acquire streamed audio of radio broadcasts.

The costs of streaming broadcast radio over the Web include license fees to the copyright holders such as music publishers' representatives and the Recording Industry Association of America, which represents record companies, in addition to hardware and networking costs. Some of these fee structures are still being negotiated at the end of the summer of 2001. A solid framework for the profitable streaming of commercial audio has not yet emerged. However, a number of digital audio subscription services offer unique and important programming which may prove to be profitable sooner than streamed commercial radio. The company Audible.com offers monthly subscriptions to daily radio programs, audio versions of national magazines and newspapers, three original programs, and hundreds of books and lectures. The content is delivered through the Web to subscribers as one of three proprietary audio file types. It is not known whether any public archive holds copies of the Audible.com programs other than those derived from public radio sources. Audible.com is one of several services that now sell spoken-word audio as computer files. The company claims to have 28,000 hours of audio, produced by 160 content partners.

Another firm, Real Networks, offers a subscription service in collaboration with major league baseball. The service enables those who pay a monthly fee to hear a live radio

feed of every major league baseball game, and allows access to an archive that includes recordings of every major league game of the season. It is not known whether any public archive would be interested in holding every baseball game radio broadcast of a season, but it would not be unusual for an archive to want to hold a home team's season or a research library with strong baseball holdings to want to build a representative collection of every baseball announcer working in the major leagues.

The Web has also given rise to what might be called private streaming radio stations. Several Web companies (e.g., Live365.com and Shoutcast.com) enable individuals to stream audio segments of their own choosing, organizing and advertising their programs under a vast variety of themes. Such indigenous radio stations, often unaffiliated with any companies or organizations, exploit the narrowcasting potential of the Web. Archives will want to document this trend and possibly preserve the programming of stations issuing very unusual content. Much of the programming on these private stations concentrates on common hit music which archives are unlikely to preserve in this format.

Web audio might also be systematically archived under the auspices of the U.S. Copyright Office, under the mandatory deposit requirements of U.S. copyright law. As subscription publications, popular radio programs such as *All Things Considered*, *FreshAir,* and *Car Talk*, as well as the daily *New York Times Audio Digest* and *Audible Los Angeles Times* are probably subject to legal demand by the Copyright Office. It might be argued that streamed Web content is subject to the same requirements.

**New Modes of Business**

Libraries and archives whose mission includes documenting contemporary music and broadcasting face great challenges in selection issues alone. A sampling of Web streaming sites might fulfill these mandates and adequately document the trend. However, independent musicians, those not affiliated with a record label, now use the Web to distribute their recordings. Web sites include tens of thousands of MP3 files available for free sampling or download for minimal payment. As with Web radio sites, music distributed on the Web can be targeted to audience niches. In theory, profits can be made on only moderate sales. Musicians tout the Web's potential for directing their work to audiences, thus circumventing record label middlemen who they believe neglect performers without mass appeal and reduce musicians' earnings. At this time, the outcome of efforts by musicians and others to recast traditional modes of music distribution is unknown. So much music was available for free through services such as Napster that it remains to be seen how many people will be willing to pay for obtaining music files from the Web.

Two Web music subscription services, MusicNet and PressPlay, are scheduled to be introduced by the five major record companies in the fall of 2001. Vitaminic, an Italian commercial Web distributor of music from independent labels and musicians, claims to manage songs by 20,000 artists and is in operation currently, as are many smaller sites created to serve independent musicians. Through these services an enormous amount of music will be available to subscribers, which may include libraries, but the audio fidelity of the files available for download will not be of high quality. The files are likely to be compressed MP3 or Windows Media files, with significantly less sonic quality than audio fixed on a compact disc or LP. The companies that manage the sites featuring independent music will not hold higher quality copies of the music. Nor are the companies likely to maintain archives of music they no longer sell. If the artists terminate their contract with a site, or if the site goes out of business, how will the music be preserved, and by whom?

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In coming years, hundreds of thousands of music files are promised to be available exclusively through the World Wide Web. No single library will be capable or desirous of preserving this abundance of content. Only a small fraction of the popular music groups whose work will be made available through these new means will ever receive national recognition. Yet some of this music will be of interest to research libraries and archives. That which is more progressive musically or contains sophisticated topical or literary song lyrics will be desired by some libraries. Libraries with a localized mission or constituency, such as those associated with historical societies or state universities, might choose to document comprehensively local musicians whose songs and music are on the Web. Harvesting these songs will be difficult. The challenges of selection are nearly overwhelming. However, the library community might aid subscription Web music sites by collaborating in the design of indexes to the sites and using those indexes to build collections. Artists who add song files to a Web site currently categorize their work by genre for inclusion in the sites' directories. Libraries might work with sites to encourage documentation of regional designations as well, to aid in the search for music of local interest. Collaboration with music sites could also extend to preservation efforts managed jointly by the sites and libraries, with the endorsement and cooperation of the artists.

**Rights Management and Protections**

The copyright controversies surrounding the creation and trading of MP3 files affect archives in a number of ways. The record industry's actions in response to the widespread violations of their copyrights include creation of protective digital rights management systems such as the Secure Digital Music Initiative (SDMI). SDMI is a digital watermark system being developed to be read by compatible hardware that will prevent illegal duplication of files. Other such systems have impeded legal uses of compact discs, including preservation. Systems intended to prevent "ripping," digital audio extraction of compact discs, or conversion of CD tracks to MP3 files, have prevented compact discs from being played at all in CD-ROM computer drives. Many experts believe that illegal copying of compact discs and other formats will never be completely inhibited. Driven by what has been termed a power struggle between intellectual property owners and customers, computer hackers will always be eager to subvert anti-piracy devices or programs, despite the law. Those less technically adept are likely to acquire hardware that circumvents digital duplication impediments by recording files from analog leads and re-converting them to non-watermarked digital files. The widespread adoption of heavily compressed MP3 files indicates that high fidelity audio is not a priority for many digital music enthusiasts. These ongoing skirmishes are likely to make record companies and other rights holders wary of cooperative preservation projects in which files might be shared between archives.

The documentation and preservation of music and the spoken word distributed through the Web is a great challenge to libraries and archives, one which no single institution is likely to be able to accomplish on its own. It has been suggested that libraries seriously interested in preserving the profusion of files of contemporary music and other audio materials available through the Web collaborate with each other. In its study on a digital strategy for the Library of Congress, the National Academy of Sciences recommends that libraries, led by the Library of Congress, define a subset of digital materials for which to "assume long-term curatorial responsibility." Such collaboration might result in the preservation of a greater percentage of available audio and reduced redundancy.

## PRESERVATION

### The "Permanent" Format and Repositories

It is only within the past two or three years that archivists have begun to accept digitization as a means to preserve audio holdings that are at risk of deterioration. In the past, librarians and archivists distrusted digital media as a format to save important audio recordings. No medium has proved stable enough to be called permanent. A significant amount of data compression has been inherent in digital sound recording, including compact audio discs, and has reduced the quality of the sound being preserved, especially in comparison with high-quality analog recordings. Several factors have led to a shift toward digital preservation. The preferred preservation medium of the last forty-five years is quarter-inch analog magnetic tape on ten-inch open reels. In 2001, only two major companies still produced the tape stock. Only a few companies manufacture the machines that play open-reel tapes. Ironically, many of the master preservation tapes produced in the 1970s and 1980s are deteriorating faster than the original older media they were intended to preserve. Many brands of tape stock manufactured less than twenty years ago are subject to hydrolysis, as the binder that adheres the recording material to the backing absorbs moisture from the air. Upon playback, the tapes squeak and break down.

Ultimately, preservation reformatting will be required for all media upon which sound is recorded, since preservationists acknowledge that there is no permanent format. Most preservationists believe that resources spent to identify and develop a permanent medium are better spent building systems that acknowledge impermanence and exploit the potential of readily available technology. Digital media have the advantage of not suffering any loss of information as they are copied, unlike the generational losses inherent in the duplication of analog media such as discs and cassette tape. The future of audio preservation is reformatting audio tapes and discs to computer files and systematically managing those files in a repository.

Digital audiovisual file repositories, in wide use by European broadcasting companies, are designed to backup their data systematically on the preferred storage format of the moment, under the assumption that that format will change from time to time. The data are to be sustained through any number of shifts in design and configuration of storage format. Digital mass storage systems (DMSS), as the repositories are called, ensure the persistence of data by validating their integrity as they are copied periodically. Such systems are complex in design and inherently dependent upon sophisticated technology which must be maintained in perpetuity. Yet, to many archivists they are liberating. The well-planned repository presumes media obsolescence, plans for it, and, according to its supporters, frees the archive community of the futile search for an affordable permanent medium.

### Digital Objects and Metadata

Digital repositories such as the one proposed for the Library of Congress call for each audio recording in the repository to be represented by a set of digital files, a "digital object." The digital object comprises the audio tracks of the recording; graphic components of the recording's packaging, such as disc labels, dust jackets, and sleeves; and metadata (which can be partitioned into "descriptive," "structural," and "administrative" metadata) about the original recording and its digital files. To archivists, the print elements of a sound recording are important components in the preservation of the sound recording. Not only must they be preserved with the recording,

they must be accessible to the researcher, in context, when the recording itself is played. Structural metadata identify and organize the individual files (termed "intermediate objects") of images and sound that represent a digitized item. The metadata assist the presentation of these from the digital repository. In a repository, structural metadata are called up by program scripts to reconstruct virtually the sound recording's packaging (scanned images of the covers, accompanying text, etc.) and to provide researchers with control over which audio tracks to audition.

In digital preservation programs, administrative metadata record exactly how an item is preserved: specifics of hardware used, hardware settings, and signal processing employed, including data compression rates. Administrative metadata include a limited amount of rights information for each sound recording preserved. Restrictions specific to the sound recording, such as donor information and the year the sound recording itself is expected to enter the public domain, is also recorded as metadata.

It is clear that the success of digital preservation efforts will rest to a significant degree on the scope and reliability of the metadata recorded. Metadata support and make possible the asset management systems that back up and periodically duplicate digital audio files in a preservation repository. Metadata can help in limiting access to intellectual property to those with proper authorizations. As descriptive cataloging information, metadata enable people to locate what they are looking for in a repository. However, full repository systems require hundreds of metadata elements for each preserved item. At this time, populating the metadata databases is very labor intensive—that is, expensive—and could be a barrier to the development of digital repositories. Among the recommendations that the National Academy of Sciences made to the Library of Congress in the *LC21* report is that "the Library should actively encourage and participate in efforts to develop tools for automatically creating metadata." Many believe that such tools are essential to the development of effective digital preservation programs.

Standards for preservation and repository-related metadata are now being developed. Work by the Audio Engineering Society and other organizations will result in refinements of Dublin Core descriptive metadata definitions as they relate to sound and guidelines for documentation of technical preservation information. The integration and standardization of competing metadata formats is only beginning to be addressed. In the field of audiovisual repository management, the Digital Library Federation's Metadata Encoding and Transmission Standard project (METS) is especially promising. METS is an XML-based format for structural, administrative, and descriptive metadata which build on the object framework outlined by NASA's Open Archival Information System. It is designed not only to assist in the management of files within a digital repository and the presentation of those files to a user, but also to enable the exchange of files between repositories. Given the high expense of professional-quality preservation, especially digital preservation, such a standard could be particularly prescient. There is no guarantee—in fact, little likelihood—that METS or any format will be adopted universally. METS is still evolving, and commercial audiovisual digital repositories that use other metadata system are already in operation.

**Standards**

The standards needed for effective digital preservation are by no means restricted to metadata. There is considerable debate among preservation recording engineers, archivists, and conservators over the principles and guidelines that direct capture from analog audio sources. There is general consensus that the digital configuration of standard compact discs, 44MHz/16bit, is inadequate, but debate over how high the

sampling rate and word length of digital preservation should be. Many engineers and conservators argue for a sampling rate of 192Mhz and word length of 24 bits, at a minimum. The diminishing costs of computer storage space have alleviated the need to process audio data with high compression algorithms. Some archivists advocate a sliding standard based on the nature of the source material, such as whether it is spoken word or music, or its frequency range. Given the frequent debates over audio standards and fervid opinions of specialists, it is unlikely that there will ever be universal agreement on standards. However, scientifically designed tests will further refine the questions debated, if not devise a resolution. The recently enacted National Recording Preservation Act directs the Library of Congress to work toward the creation of standards for digital preservation.

Most archivists now agree that the initial preservation capture of audio should be a flat transfer of the source signal. The master preservation file or recording should not include any playback curve or signal processing, such as that used to reduce analog disc surface noise. Standard equalization curves used on the analog source recordings are noted in metadata. Computer controlled playback devices can then reintroduce the equalization during playback. Recently developed digital audio workstations aid in recording this technical metadata, including the condition of the source, as well as its technical characteristics. However, most existing digital audio workstations are designed for production, not preservation transfers, and require further enhancements to meet the standards of preservationists. Many otherwise sophisticated digital audio workstations currently available do not allow digital recording at high sampling rates, such as 192MHz.

## CONCLUSION: THE IMPORTANCE OF COLLABORATIVE APPROACHES

At this time, there is virtually no coordination of preservation efforts between commercial archives, such as those of the record companies, and institutional archives. While this might not be surprising given their different missions, there are legitimate reasons why collaboration could be mutually beneficial. According to an award-winning series of articles in *Billboard* magazine, record companies have discarded thousands of master recordings and thus hold incomplete archives of their intellectual property. No central database or file of master recordings exists. Such a database was attempted in the 1990s but companies were reluctant to share what they felt was proprietary information. Many of the major record companies' releases are held only by collectors and institutional libraries and archives. Companies and archives might wish to pursue collaborative preservation projects whereby 78-rpm discs and LPs held by institutional archives are digitized jointly and companies' digital sound files are shared with archives in a controlled setting.

Such collaborative projects would not be easy to undertake. Record companies feel bruised by the rampant swapping of music files propagated by programs such as Napster and may be reluctant to authorize the use of master files outside their domains, however strictly they are controlled. In fact, copyright laws, particularly those enacted to reduce digital piracy, now can prohibit legitimate and necessary preservation functions.

Whether between record companies and archives or with others, some type of collaborative approach to audio preservation will be necessary if significant numbers of audio recordings at risk are to be preserved for posterity. Hundreds of thousands of magnetic tapes and fragile discs stand to be lost if they are not preserved in the next twenty to fifty years. The cost will be in the tens of millions of dollars. One particular

risk of preservation programs now is redundancy. Archives capable of creating high-quality preservation master files have few means to ensure that other archives have not preserved the same files. Descriptive metadata are often derived from library catalog records that do not identify unique musical performances or do so in a non-standardized format that is difficult to exchange. Nor does most descriptive metadata now being created provide detail at the high level of granularity required to fully identify the musical compositions that make up a recording (for example, composers' names and dates of compositions). Publishers and performing rights organizations do maintain such information, but it is not available for population of public databases.

The sharing of nearly all preserved audio files is illegal under current laws, which place restrictions on audio recordings made as long ago as the nineteenth century. If rights holders could be assured that piracy of their music would not result, special licenses or agreements with intellectual property holders might be devised to provide wider access to out-of-print and unpublished recordings. Many archivists believe that adequate funding for preservation will not be forthcoming unless and until the recordings preserved can be heard more easily by the public. Archives are interested, and could be active, effective partners in the creation of subscription services, which include a variety of music now wider than that available in the commercial market. Many would be willing to share their files of preserved audio files with other institutions or individuals if reciprocal agreements could be formulated legally.

Record companies are engaged intensely in providing customers with an alternative to Napster that will generate income for the record industry and prevent piracy of music. The major subscription Web sites for music will probably concentrate on contemporary music and the history of rock and roll. The universe of musical riches promised by celestial jukeboxes is not likely to include a wide selection of historical sound recordings that represent the full breadth of recorded music. This is certain to be true if they are not preserved and documented properly. If audio recordings that do not have mass appeal are to be preserved, that responsibility will probably fall to libraries and archives. Within a partnership between archives and intellectual property owners, archives might assume responsibility for preserving less commercial music in return for the ability to share files of preserved historical recordings.

All audio preservation is expensive; it is estimated that preservation engineers' studio time required for a recording averages three times the length of the source recording. Digital preservation holds great promise but it adds significant investment costs, such as the creation and maintenance of repositories, and the generation of controlling metadata. Whether for lack of foresight or funding, digital mass storage systems for audiovisual works, common in broadcasting archives, are not being created by libraries. We face an extraordinary dilemma: at a time when a greater range of audio is available to more people than ever before, and the means are finally at hand to preserve those sounds for posterity, we stand the greatest risk of losing them.

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